Structural dynamics and mechanics of the cytoskeleton – insights from a giant muscle protein

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The cytoskeleton is a dynamic filamentous protein polymer network that traverses the cytoplasm of all known cells, including eukaryotic and prokaryotic. Its filaments, the microtubules, actin and intermediate filaments, or their analogs, together with a myriad of associated proteins, provide basis for cellular structure, shape, viscoelasticity, motion, transport, and highly specialized and complex processes such as division. Furthermore, by serving as a three-dimensional template, the cytoskeleton provides a spatio-temporal guiding pattern for essentially all intracellular molecular reactions and phenomena. In striated muscle, which is one of the most highly differentiated cells, a unique cytoskeletal network is present, the most important component of which is titin. Titin is the largest polypeptide known to date. Its spatial location and arrangement, along with its structural and mechanical properties, makes titin uniquely suited to control and tune the developmental and functional features of muscle. Furthermore, as titin has been detected in numerous other places such as the smooth muscle and leukocyte cytoplasm, and even the cell nucleus, its function may stretch much beyond what is conventionally known about this special protein.

Investigation of the cytoskeleton and its associated proteins involves a wide range of unique methodologies ranging from high-resolution fluorescence to optical tweezers and atomic force microscopy. In this presentation the methodological approaches will be addressed as well.